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USING TEXT-TO-IMAGE GENERATOR FOR INDUSTRIAL DESIGN IDEATION: A CASE STUDY IN LIGHTING-INSPIRED DESIGN

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Abstract:

Idea generation is a critical component of industrial design education, serving as the foundation for creativity and innovation in the field. Equipping students with effective idea generation skills is essential for producing outstanding designs. However, the translation of conceptual ideas into impactful visual representations remains a challenge. Conventional methods, relying solely on visual sketch descriptions, often constrain the creative process and limit design possibilities, risking the compromise of originality through overreliance on established trends. In this context, the emergence of generative Artificial Intelligence (AI), particularly text-to-image technology, presents a transformative solution. This paper delves into the potential of leveraging text-to-image generation in industrial design education, specifically focusing on lighting-inspired design. The objectives of this study encompass exploring the method's potential in the early stages of idea generation, providing practical recommendations for educators and students, and analyzing associated challenges. This study conducted with 23 Bachelor of Industrial Design students in College of Creative Arts, UiTM Kedah, who been given task to developed a concept for lighting-inspired design using these popular text-to-image generators: recraft.ai, stablecog.com, and ideogram.ai. The study employs two stages of idea generation, which are, Stage 1 involves inputting text prompt to generate an image while Stage 2 employs Text-Guided Image-to-Image using image provided in stage 1. Through carefully crafted prompts, this methodology encourages users to explore diverse design alternatives while maintaining alignment with specific objectives. As an educational tool, it facilitates a deeper understanding of design principles, aesthetics, and visual composition. The key lies in using design-related terminology in well-structured prompts to ensure relevant results. It is crucial to acknowledge that, although this technology enhances design aesthetics, consideration for technical viability and functional aspects remains imperative. By addressing potential challenges and limitations, educators and students can maximize the

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tool's potential to expedite idea generation, stimulate creativity, and ultimately foster innovation.

Keywords:

lndustrial Design, Idea Generation, Text-to-Image generator, Image Prompt

Background And Significance Of Idea Generation In Industrial Design Education

The process of idea generation indicates the initial phase where various ideas are proposed, offering a range of options. Initiating this method is not always a linear process. Individuals are not limited to a single technique for initiating idea generation; rather, they have access to a variety of methods (Sun, & Münster, 2018). Students are frequently given exposure to these techniques in design schools, which facilitates familiarity and exploration. This exposure enables designers to not only develop attitudes and interests, but also a knowledge base (Oustamanolakis, M., 2022). The techniques employed for idea generation and problem-solving strategies contribute to the larger body of design knowledge. Design education such as Industrial Design field places significant emphasis on idea generation as a foundation of the design process (Cañizares et al, 2023). In the past, industrial design students relied on traditional methods to find resources and gather inspiration for their design projects (Brown, 2009). In order to gather information, students would engage in manual methods such as searching through books, visiting libraries, attending design exhibitions, and conducting actual material study. Although valuable, these approaches were often time consuming and limited in accessing a wide range of design references.

However, with the advent of technology and the generation of the internet, the process of finding resources has undergone a transformative shift. Today, students can easily access vast information and visual references with just a few clicks. Websites, online platforms, and search engines have become indispensable tools in the quest for inspiration and knowledge (Sun et al, 2018). Websites related to design, such as industry blogs, online design magazines, and professional networking platforms, offer students a wealth of resources. Students can explore these resources to gain insights into successful design solutions, understand user preferences, and stay up to date with the latest design trends (Sun et al, 2018). Furthermore, search engines like Google have revolutionized the way students find visual references for their design projects. Students can explore an extensive collection of images that align with their design objectives by entering specific keywords. This enables them to examine existing design solutions, analyze visual aesthetics, and draw inspiration from various design styles, forms, and contexts (Sun et al, 2018).

Overview Of The Role Text- To-Image Generator In Idea Visualization

Nowadays, text-to-image technology has revolutionized the visual process in creative industries by effortlessly translating textual prompts into captivating visual representations. This innovative approach bridges the gap between words and imagery, thereby fostering creative thinking and facilitating effective communication among designers (Oppenlaender, 2022). Additionally, web-based applications like ideogram.ai, recraft.ai and stablecog.com have emerged as user-friendly platforms to harness this transformative technology, allowing individuals to effortlessly transform their thoughts and concepts into visually engaging designs (Crowson et al, 2022). However, the use of text-to-image when crafting content through text,

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users find themselves with limited control over how the final piece is put together or how the subject is presented.

The introduction of Text-Guided Image-to-Image generator significantly enhances the idea visualization process, allowing users to experiment with diverse visual interpretations of their concepts, thereby expanding their creative horizons and design possibilities. By visually depicting their ideas, users gain a clearer understanding and expression of their thoughts, facilitating seamless revisions and iterations to refine their designs further (Qiau et al, 2022). Furthermore, the utilization of Text-guided image-to-image plays a crucial role in encouraging and guiding the production of ideas. Thoughtfully designed text-guide image prompts serve as effective stimuli, directing users' thinking towards exploring multiple viewpoints and potential solutions. By stimulating fresh perspectives and pushing the boundaries of creativity, these prompts allow users to generate a wide variety of design alternatives. When users engage with text-guide image-to-image generator, they are encouraged to think strategically and critically, ensuring that their generated ideas align with the specific design objectives and requirements (Qiau et al, 2022).

Problem Statement:

Despite the importance of idea generation in the field of industrial design education, students often face challenges in effectively translating their conceptual ideas into visual representations (Bruseberg and McDonagh-Philp, 2002). Conventional methods relying solely on visual sketch descriptions may hinder the creative process and limit the scope of design possibilities (Conradie et al., (2015), Botella, 2018). For example, relying too much on established design trends may hinder creativity and result in duplicated solutions (Linsey et al., 2010). Additionally, students could have trouble getting past creative obstacles and coming up with truly original ideas. To address this issue, there is a need to explore innovative approaches that can bridge the gap between words and imagery, allowing students to express their ideas more vividly and enhance the quality of their visual outcomes in industrial design projects.

The aim of this research is to explore the effectiveness of text-to-image generators as a tool for enhancing the ideation process in industrial design, specifically within the context of lighting-inspired designs. This study seeks to evaluate how these AI-driven tools can facilitate creativity and innovation, ultimately contributing to the development of more original and diverse design concepts

The Research Objectives:

1. To explore the potential of text-to-image generator in the early stages of idea generation for thumbnails in industrial design.
2. To provide practical recommendations and guidelines for educator and industrial design students in enhancing their idea generation process using the method of text-to-image generator.
3. To analyze challenges associated with the utilization of text-to-image generator in the context of industrial design education, offering insights into potential obstacles and limitations.

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Literature Review

Definition and Importance of Idea Generation in the Design Process

In the design process, idea generation stage is crucial in industrial design education. It requires coming up with genuine creative ideas that successfully solve design problems. Exploration, conceptualization, and refining processes are used at this stage to meet user needs, industry standards, and improvements in technology. Idea generation is the primary component of the entire design process (Oustamanolakis, M., 2022).

The importance of idea generation in the field of industrial design education cannot be emphasized. It acts as an opportunity for students to develop their critical thinking, creativity, and problem-solving abilities. Students are encouraged to think beyond the box by encouraging the invention of a wide variety of ideas, which results in the creation of original design solutions. Idea generation also enables students to explore different design directions, consider multiple perspectives, and push the boundaries of their creativity to develop impactful designs. Idea creation promotes an environment of discovery and experimentation where students are allowed to explore a wide range of options without worrying about being judged by others (Cañizares et al, 2023). Additionally, as students learn to deal with complexity and modify their ideas in response to fresh knowledge or criticism, idea generation encourages adaptation.

Current Practices and Challenges in Industrial Design Education

Various techniques are currently used in industrial design education with the goal of encouraging students' idea development and creativity. Idea research and exploration is one of the common strategies. Students are encouraged to conduct in-depth study, evaluate existing designs, and look for inspiration in a variety of places, including works of art, the surroundings, and cultural references. Students' design concepts are consequently enhanced by this practice, which aids them in developing a greater understanding of design trends, user preferences, and market demands (Brown, 2009).

Another common method to generate ideas by sketching on paper or in drawing software such as Autodesk Sketchbook Pro. Students can visualize and polish their ideas on paper by sketching, which speeds up the exploration of many design options. Students can iterate and adapt their concepts through this iterative process, which results in effective design solutions. In addition to sketching, inspiration boards are becoming more common. These boards act as visual collages that combine pictures, textures, colors, and other design-inspiring materials. Students can visualize the entire aesthetic direction and atmosphere of their projects by making such boards, which helps with the clear development of design concepts.

The idea generation process encompasses a comprehensive series of steps that facilitate a holistic and creative approach to design. For example, based on the Diploma in Industrial Design at UiTM Kedah Branch, particularly in the subject IDT160 (Introduction to Industrial Design) project (refer Figure 1).

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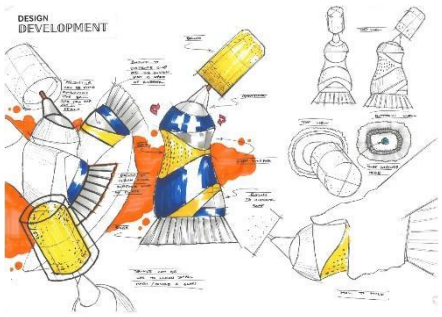
Thumbnails/Ideation Sketches:
Students work through ideation exercises and thumbnail sketches at the beginning of the idea generating process. This stage enables students to quickly explore a variety of design options, advancing creativity and challenging them to think beyond the box. Students can see several design options and pinpoint potential project directions through these preliminary sketches.

Idea Development sketches:
Students continue on to the idea development stage after using thumbnails to generate a wide variety of concepts. Here, they select the most interesting concepts and attempt deeper to develop and refine them. The target user must be taken into consideration, the strengths and limitations of each idea must be evaluated.

Design Development sketches:
Students continue on to the design development phase after choosing the concepts that are most probable to be effective. They translate their more developed concepts into more intricate and thorough designs. In order to develop carefully constructed and workable design solutions, this step involves integrating technical issues, material study, and the integration of design principles.



Mock-up Development:
Students are so encouraged to produce actual prototypes and mock-ups of their designs. Students can evaluate their designs in a practical way by creating physical representations of their ideas, which gives them important insights into the practicality and validity of their concepts.

Final Design:
The final design is the last stage in the concept generation process. Students revise their designs based on input from mock-ups and further revisions until they have a polished and well-executed final result. The finished design demonstrates their capacity to combine form, function, and user-centered concerns into an appealing and persuasive design solution.

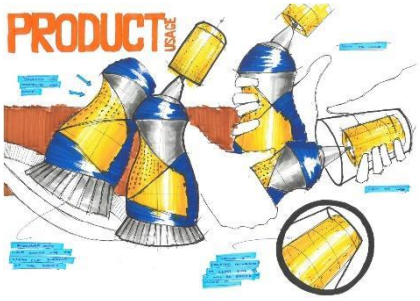


Figure 1: Current Practice Design Process in Diploma in Industrial Design in IDT160 Course.

Source: Sketches by Syakir Mitaa, Year 1, Industrial Design Student

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Even though these current methods are effective, using traditional idea generation techniques can be difficult. The limited ability to express and visualize design concepts presents a significant obstacle. Despite encouraging students to explore and visualize their ideas through sketches and inspiration boards, some students continue to struggle with expressing their concepts, which may lead to misinterpretations during project development. In addition, students may feel bound to comply to established design trends, limiting their exploration of original and creative design solutions (Linsey et al., 2010). Moreover, creative blockages may block the process of idea generation, limiting students' ability to generate fresh and creative concepts. These roadblocks may be caused by external pressures, time constraints, or personal fears, requiring the use of effective strategies to overcome them (Botella, 2018). Furthermore, students may not receive adequate guidance on refining and developing their ideas, which balancing aesthetics with functionality remains a delicate task for students, who must create visually appealing designs while ensuring their practicality and usability. Time constraints inherent in educational settings may also limit in-depth exploration and thorough idea development.

Text-to-Image in Design Education

Text-to-Image conversion technology has emerged as a game-changer in design education by providing a seamless transition from text-based ideas to visually compelling representations. The development of text-to-image websites and applications such recraft.ai, stablecog.com, and Ideogram.ai is a result of the popularity of text-to-image generator technology. These platforms allow designers the choice to use a variety of subscription plans, including both free and paid options, to gain access to this powerful technology. These text-to-image websites have a number of benefits, including user-friendly interfaces that are simple to use and accessible to designers of all skill levels. Without significant technological experience, students can quickly translate their text-based design descriptions into visual representations thanks to the minimum settings and simple navigation. However, to further enhance the idea generation process, the integration of "text-guided image-to-image generator" holds immense potential. This method serves as visual cues or starting points that trigger creative thinking and guide students in exploring design concepts from various angles (Qiau et al, 2022).

By combining text-to-image with good prompting, students can benefit from a two-fold approach. Firstly, they can input textual descriptions of their design ideas into the web-based application, generating initial visual thumbnails or rough drafts. These generated images can serve as a basic for further exploration. Secondly, the integration of text-guided image-to-image with a good prompt allows students to more control over the composition and realization of their creative goals (Qiau et al, 2022). These prompts can be carefully curated to evoke certain design themes, emotions, or styles, providing students with inspirational references and encouraging them to consider alternative directions for their designs (Liu and Chilton, 2021). Apart from that, the use of image prompts also helps address the challenge of dependence on established design trends. By presenting diverse and unconventional base images, students are encouraged to think beyond the familiar and venture into uncharted creative territories. Moreover, with the use of initial image as a base for this method, it greatly enhances the coherence and recognition of the subject (Qiau et al, 2022).

Furthermore, the combination of text-guided image-to-image with prompts streamlines the ideation process, enabling students to rapidly explore multiple design options. As they receive instant visual feedback, they can iterate and refine their concepts swiftly, allowing for a more

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efficient and iterative design process (Qiau et al, 2022). However, it is crucial to strike a balance between the influence of image prompts and the students' original ideas. The prompts should act as springboards for creativity rather than constraints, allowing students to infuse their personal flair and individuality into the designs (Liu and Chilton, 2021). Additionally, providing students with the opportunity to customize and modify the base images can further enhance their sense of ownership and creative expression. Example lighting inspired product on text-to-image generator using platform stablecog.com. (refer Figure 2).

Figure 2: Example of Text-to-Image in *stablecog.com* Web-Based Application. Prompt: Standing Desk Lamp, Form inspired by Nao Tamura Season/Covo leaf, Organic Shape, Minimalist and Modern Design Style.

Methodology

Case Study: Idea Generation using Text-to-Image generator in Lighting-Inspired design

This study incorporates 23 Bachelor of Industrial Design students in College of Creative Arts, UiTM Kedah which to explore the potential of text-to-image generator in enhancing idea generation for lighting-inspired design. The study employs two stages of idea generation which are, Stage 1 involves inputting prompt text to generate an image while Stage 2 employs Text-Guided Image-to-Image by using these web-based application which are *recraft.ai, ideogram.ai* and *stablecog.com*

Stage 1: Prompt Text In Text-To-Image Web-Based Application

The students begin by creating visual representations of design concepts using the text-to-image web-based application which stimulated by inputting textual prompts to obtain visual thumbnails that illustrate the early design ideas and conceptions of lighting inspired design. The basic prompt that student need to follow is "*<type of lighting>, inspired by <subject>, <concept> design style"*.

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Stage 2: Text-Guided Image-To-Image Web-Based Application

Next, the students use image-to-image generator for selected generated image in Stage 1. In this step, a curated list of prompts is developed to align with their lighting-inspired design. Each prompt aligns with the case study theme and is carefully selected to reflect the intended aesthetics. The students then attaching generated lighting-inspired design image provided in Stage 1 into image-to-image web-based application to simulate the process of exploring different design style directions. This is because, the usage of initial images needs to be closely with the subject intended, because the idea that generate is more realistic depiction of the subject, and consistently improves subject representation (Qiau et al, 2022).

Result of Data

Stage 1: Text-to-Image Generation

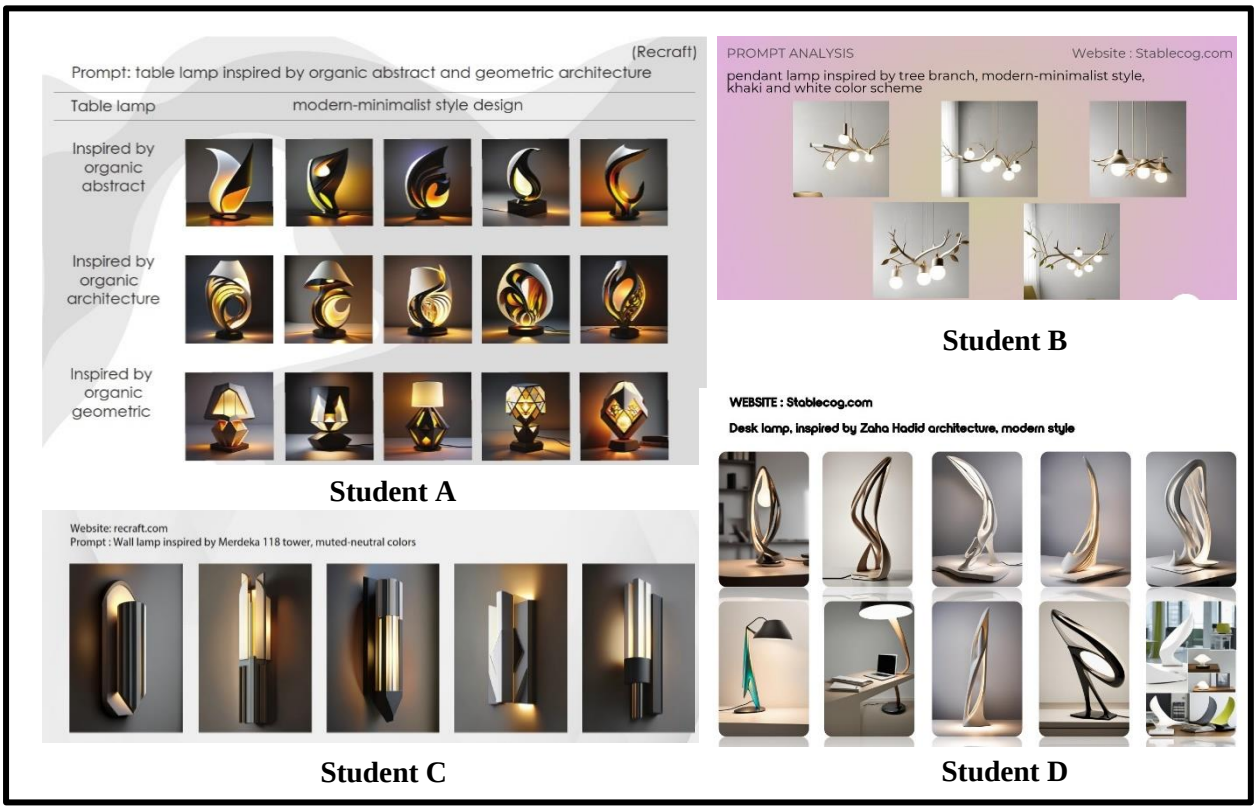

Figure 3: Example Compilation Result of Text-To-Image Generated Lighting-Inspired Design By The Students

In Stage 1, the text-to-image generator efficiently produced a series of image thumbnails based on the prompts provided by the students, which focused on lighting-inspired designs (Refer to Figure 3). The generated designs, while occasionally displaying minor inconsistencies in proportions and logic, effectively captured the essential shape and line profiles of the lighting products. These initial image thumbnails laid a solid foundation for further refinement in Stage 2.

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Stage 2: Image-to-Image Generation

Building on the outcomes from Stage 1, the students selected their preferred lighting-inspired designs and used them as input for the image-to-image generator on *Stablecog.com*. This process involved refining the initial designs by incorporating additional prompts to achieve more detailed and stylistically aligned outcomes. The image-to-image generation process was crucial in guiding the students to explore diverse design styles and achieve more cohesive final designs (Refer to Table 1). The results from both stages demonstrate the text-to-image generator's potential as a tool for idea generation in industrial design education. Despite the occasional inconsistencies in technical aspects, the generator significantly enhanced the students' ability to visualize and iterate on their design concepts. The iterative process between text-to-image and image-to-image generation allowed the students to explore multiple design directions, leading to a more comprehensive development of their ideas.

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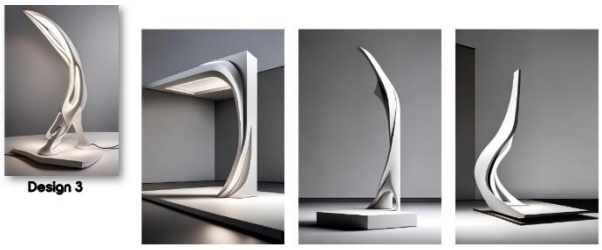
Student	Generated Image-to-Image	Support prompt
A		Minimalist form
B		Modern-minimalist style
C		Contemporary-modern design style, geometric form
D		Modern-simple form

Table 1: Example Result of Lighting-Inspired Design in Text Guided Image-To-Image Generator Produce By The Students

Discussion

Exploring the Potential of Text-to-Image Generators in Early Idea Generation for Thumbnails in Industrial Design

Text-to-image generators hold significant potential in transforming the early stages of idea generation, particularly in the creation of thumbnails, which serve as the initial visual representations of design concepts. These tools allow designers to input specific textual prompts and receive multiple visual outputs, each offering a unique interpretation of the idea.

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This capability not only accelerates the thumbnail creation process but also introduces a level of creativity and diversity that might not be achievable through traditional methods.

For instance, a designer working on a lighting fixture might input a prompt describing a "modern, eco-friendly lamp with organic shapes." The text-to-image tool could then generate a series of thumbnails, each highlighting different aspects of this concept which some focusing on the modern aesthetic, others emphasizing eco-friendliness, and still others interpreting organic shapes in various ways. This process enables designers to explore multiple directions simultaneously, quickly assessing which ideas have the most potential for further development.

While traditional methods rely heavily on the designer's existing knowledge and creativity, the text-to-image tools introduce an element of surprise, presenting visual ideas that the designer might not have conceived independently. This not only broadens the scope of initial ideas but also fosters innovation by challenging conventional design thinking.

Providing Practical Recommendations and Guidelines for Educators and Industrial Design Students

Incorporating text-to-image generators into the educational framework of industrial design requires careful consideration of how these tools can best be utilized to enhance the ideation process. To this end, a structured approach can be adopted by educators and students to maximize the benefits of technology text-to-image design. The following step-by-step guide offers a practical method for integrating text-to-image generators into the design workflow:

- **Define the Design Brief:** Begin by clearly articulating the design problem or brief. This sets the foundation for generating relevant and focused ideas.

- **Crafting Input Prompts:** Students should learn to create precise and creative prompts that guide the technology in generating images aligned with the design objectives. For example, specifying "a minimalist table lamp with a touch of Art Deco" can yield more relevant outputs than a vague description.

- **Refining Generated Images:** After the text-to-image generates thumbnails, students should critically evaluate and refine these images, combining elements from multiple outputs or adjusting details to better fit the design brief.

- **Integrating into the Design Process:** The selected image generated ideas should then be developed further through traditional sketching or digital, ensuring that the final design reflects both the generated image inspiration and human creativity.

Educators can support this process by providing examples of effective prompt creation, offering feedback on technology-generated thumbnails, and encouraging students to critically assess the originality and practicality of the text-to-image outputs. Best practices include using diverse and specific prompts, balancing technology-generated ideas with traditional design methods, and fostering an understanding of the tool's strengths and limitations.

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Analyzing Challenges Associated with the Utilization of Text-to-Image Generators in Industrial Design Education

While text-to-image generators offer substantial benefits, several challenges must be addressed to ensure their effective integration into industrial design education. One significant technical limitation is the current text-to-image technology inability to fully grasp and replicate complex design intentions. For example, while the text-to-image tool might generate visually appealing images based on a prompt, these images might lack the depth and functionality that a human designer would consider essential. Additionally, the text-to-image tools are often trained on vast datasets, which can introduce biases or lead to outputs that are overly generic or derivative. This poses a challenge in design education, where originality and innovation are paramount. Educators must teach students to recognize and mitigate these biases, perhaps by encouraging the combination of text-to-image outputs with traditional design methods or by refining the image outputs to better align with the design brief.

From an educational perspective, another challenge is the risk of students becoming overly reliant on text-to-image tools, potentially stifling their own creativity. It is crucial that these tools are presented as a supplement to, rather than a replacement for, human creativity. Educators should emphasize the importance of critical thinking and encourage students to use text-to-image generated ideas as a starting point for further exploration and refinement.

Conclusion

In conclusion, the exploration of text-to-image generators in the context of industrial design, specifically for lighting-inspired designs, has revealed their significant potential in enhancing the early stages of idea generation. These AI-driven tools have demonstrated their ability to produce diverse and innovative visual outputs that can inspire designers in the creation of thumbnails, providing a valuable supplement to traditional design methods. By rapidly generating multiple design ideas based on specific prompts, text-to-image generators can accelerate the ideation process, enabling designers to explore various directions more efficiently. To fully harness the potential of these technology, it is crucial for designers to develop specific skills. Proficiency with web-based applications is necessary for obtaining accurate and meaningful visual outputs. Additionally, crafting precise prompts using relevant design terminology such as specifying design styles, lines, shapes, and supported elements is essential for generating visually aligned and purposeful results. For instance, prompts like "<*Subject*> inspired by <*Design Style*>, with <*Supported Design Elements*>" can help guide the generator to produce more targeted visuals.

However, the research also highlights several challenges associated with the use of text-to-image generators in industrial design education. Technical limitations, such as the inability of current AI tools to fully capture complex design intentions, and the potential for bias in technology-generated outputs, pose significant obstacles. Additionally, there is a risk of students becoming overly reliant on these tools, potentially stifling their own creativity. To overcome these challenges, it is essential to encourage a balanced approach that combines text-to-image generated ideas with traditional design methods. Educators should emphasize the importance of critical thinking. By addressing the challenges and maximizing the benefits of these tools, designers and educators can harness the full potential of text-to-image technology to push the boundaries of design. Future research could further investigate specific case studies to better understand how these tools influence the creative process. The successful integration of these tools into design education will depend on ongoing critical assessment and adaptation,

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ensuring they are used effectively in enhancing creativity and maintaining the balance between technology assistance and human creativity.

Future research could focus on developing and accessing educational strategies for effectively integrating text-to-image generators into industrial design curriculum. This includes exploring teaching methods that balance text-to-image tools enhanced creativity with traditional design skills. Studies should investigate how to help students master these tools while critically evaluating text-to-image tool outputs for biases and limitations. Additionally, research could examine the impact of this technology integration on student creativity, learning outcomes, and the quality of design solutions. By refining educational approaches, educators can better prepare students to leverage this tools while maintaining a strong foundation in traditional design principles.

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